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AN ISOLATED PRAIRIE GROVE AND ITS PHYTOGEOGRAPHICAL SIGNIFICANCE¹

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(WITH TWO FIGURES)

Probably less study has been given in recent times to the relation of prairie and forest than to any other general phytogeographical problem in the central states. Some of the large number of questions still awaiting satisfactory solution were briefly stated in a former paper,² and in the following pages some evidence bearing on one of them is given and some conclusions of a more general nature are drawn. The present paper is not so much a description of modern conditions as an attempt to explain by existing distribution certain historical features of the relation of forest and prairie in central Illinois. It is probable that the conclusions drawn from the local area apply equally well to many other portions of the eastern extension of the Prairie Province.

Early histories and maps show that the prairies of central Illinois were not continuous, but occupied chiefly the higher ground between the drainage systems. The latter were bordered in their lower courses by forests, which occupied the floodplain and bluffs and extended out a short distance on the uplands. The sources of the streams were usually in the prairie, and their margins were occupied by prairie vegetation for the first few miles. Scattered about on the prairie were a few isolated groves, far removed from the larger bodies of forest along the water courses. These groves were important to the Indians and early settlers as landmarks and camping grounds, and at a later period formed centers from which the settlement of the prairie proceeded. Bur Oak Grove is an example of such an isolated area of forest. It is situated in the east-central part of Champaign County, on the east side of the

¹ Contribution no. 123 from the Botanical Laboratory of the University of Michigan.

² Some unsolved problems of the prairies. *Bull. Torr. Bot. Club* 36:265-271, 1909.

Chicago and Eastern Illinois Railway, not far from the village of Royal. There were several other isolated groves in the county, most of which have been entirely destroyed by cultivation. Of these, Bur Oak Grove is the largest and the most significant phytogeographically. The remaining forest areas of the county are along the Sangamon and Kaskaskia rivers, and Salt Fork of the Vermillion River. The last two rise in the county, and the upper five to ten miles of their course is in the prairie.

The present length of Bur Oak Grove is about three miles from northeast to southwest, and its width about one mile. It is certain that it was originally somewhat longer, and it probably had a greater average width. Its outline is and has always been very irregular. In recent years cultivation has broken it up into many small detached portions. There is no easily accessible map showing the location of the grove in detail. The Urbana sheet of the Topographic Survey just misses the grove on the west. Just southwest of Bur Oak Grove, however, are two or three other detached groves of similar topography which appear on the map. These areas are indicated in green near Glover station. The peculiar topography associated with these groves is scarcely shown, even on a map with contour intervals at ten feet.

The most striking physical feature of the grove is its peculiar surface topography. Surrounded on all sides by level prairie country, it is sharply and conspicuously distinguished by its irregular surface, which consists of alternating elevations and depressions. The elevations are of about the same height, and the intervening depressions are also of a very uniform depth. The width of the depressions varies from a hundred feet to a quarter of a mile; their length from a few hundred feet to half a mile, or perhaps more; and their depth is usually about ten feet. Their shape accordingly varies from almost circular to linear, and those of the latter shape frequently resemble abandoned channels of some water course. They lie in every conceivable position, and may branch or anastomose in any way. As a result of the general irregularity, the intervening elevated ground may consist of circular islands, extended surfaces, or long and narrow, straight, curved, or branching ridges. For convenience, they are here always

referred to as ridges, irrespective of their shape, while the depressions are called sloughs, after the general usage of the region. The slope from ridge to slough is always gentle, never exceeding and seldom reaching 10° . No attempt will be made to explain the origin of this peculiar topography, except to suggest that it may be in some way connected with or caused by the glacier which deposited the conspicuous moraine a few miles farther north.

These sloughs received all the surface drainage from the ridges, and were originally filled through most of the year with standing water. During the spring rains they overflowed at the lowest point in their margins into neighboring sloughs, and in this way the whole area was converted into a network of ponds. During the summer the water was lost by underground drainage and evaporation, until by October some of the sloughs were entirely dry.

These conditions have greatly restricted agriculture, and it is to them that the grove owes its preservation. With the increasing value of land, tile has been laid, ditches dug, and most of the sloughs reclaimed. In them the soil is black and deep and is generally planted to corn. Others are left in pasture, although they support a better growth of weeds than of grass. A few are so deep that they cannot be profitably drained, and are still occupied by permanent ponds. Probably half a dozen of these ponds are left, and they now constitute the only natural bodies of permanent standing water in the county. Although the soil on the ridges is not so black or so deep as on the surrounding prairies, a part of the forest which covered them has been cleared, and the staple crops are grown. The rest of the forest is used for permanent pasture.

The forest cover of the ridges shows a considerable variation in specific composition from south to north. Near the south end the forest is open, the trees are comparatively small, and there is scarcely any deposit of leaf mold (fig 1). The prevailing trees are *Quercus imbricaria*, *Q. velutina*, *Carya ovata*, *C. cordiformis*, with occasional trees of *Juglans nigra*. The actual proportion of these species varies widely. *Quercus imbricaria* is usually most abundant, but there are some small areas in which *Carya ovata* is dominant. The trees now seldom exceed a foot in diameter, but the present forest is almost

entirely second growth. Old stumps may be seen which are two feet or more in diameter, and a few veteran trees are still standing. The forest is open enough to permit the growth of blue grass, and the continual pasturage has resulted in the destruction of nearly all the native herbaceous species. The chief native plants remaining are *Muhlenbergia Schreberi*, *Geum canadense*, *Sanicula canadensis*, and *Veronica virginica*, and occasionally a small thicket of *Corylus americana*. *Verbascum Thapsus* and some other introduced weeds are frequent. At the margin of the forest there are



FIG. 1.—Forest at south end of the grove; *Quercus imbricaria* is here the dominant tree.—Photograph by ARTHUR G. VESTAL.

in some places small thickets of *Pyrus coronaria*, *Crataegus* sp., *Prunus americana*, and *Viburnum prunifolium*.

Near the middle of the grove, from south to north, several other species of trees are common. Most important among these in size and number is the bur oak, *Quercus macrocarpa*, which gave the grove its name. A few large trees, three to four feet in diameter, serve to give some idea of the dimensions of the original stand. There are also numerous trees of *Juglans nigra*, *Ulmus fulva*, *Celtis occidentalis*, *Prunus serotina*, and *Gleditsia triacanthos*. The four species of the south end of the grove are still present, although naturally relatively less abundant. Near the margin of this portion

of the forest, and in the more open places within it, avevectent shrubs are abundant. The commoner ones are *Smilax hispida*, *Menispermum canadense*, *Crataegus Crus-galli*, *Crataegus* sp., *Evonymus atropurpureus*, *Celastrus scandens*, *Psedera quinquefolia*, *Vitis vulpina*, *Zanthoxylum americanum*, *Sambucus canadensis*, and *Viburnum prunifolium*. Where the forest is too dense to permit the growth of blue grass, many of the original herbaceous species still persist. Among them the following were listed: *Dioscorea villosa*, *Parietaria pennsylvanica*, *Polygonum virginianum*, *Phytolacca decandra*, *Silene stellata*, *Anemone virginiana*, *Aquilegia canadensis*, *Heuchera hispida*, *Agrimonia mollis*, *Rosa setigera*, *Lespedeza frutescens*, *Amphicarpa monoica*, *Polygala Senega* var. *latifolia*, *Viola* sp., *Sanicula canadensis*, *Seymeria macrophylla*, *Triosteum perfoliatum*, *Campanula americana*, *Helianthus strumosus*, *Verbesina helianthoides*, *Aster Drummondii*, *Lactuca villosa*.

In the northernmost part of the grove the four trees of the southern end still persist, but are much less abundant than other species. *Quercus macrocarpa*, *Juglans nigra*, *Celtis occidentalis*, and *Ulmus fulva* are common; *Gleditsia triacanthos* grows 60-80 feet high; there are a few trees of *Prunus serotina*, *Ulmus americana*, and *Populus grandidentata*, and, most notable from an ecological viewpoint, *Quercus rubra* and *Tilia americana* appear. At the northeast corner of the grove *Quercus rubra* is the dominant species, with the largest living trees about three feet in diameter. In this part of the grove there is a conspicuous deposit of leaf mold on the ground, and the forest cover produces a denser shade. As a result, the herbaceous vegetation is decidedly mesophytic and includes many species which are typically members of the climax forest association. Among these are *Arisaema triphyllum*, *Allium tricoccum*, *Trillium recurvatum*, *Smilax ecirrhata*, *Pilea pumila*, *Ranunculus abortivus*, *Podophyllum peltatum*, *Impatiens pallida*, *I. biflora*, *Circaea lutetiana*, *Cryptotaenia canadensis*, *Phlox divaricata*, *Pentstemon laevigatus* var. *Digitalis*, *Phryma Leptostachya*, *Galium concinnum*, and *Eupatorium urticaefolium*. Avevectent shrubs are not so common as in the middle portion of the forest, and blue grass grows only in partial clearings.

Direct observation shows at once that the forest is always con-

fined to the ridges, and measurement with a Locke level or alidade not only confirms this idea, but shows that the lower and outer margin of the forest follows a definite contour line, so that the forest margins on all sides of a slough lie at exactly the same level. This contour line is approximately two feet above the maximum level of standing water in the slough. The forest margins on opposite sides of a ridge will be at the same level if the sloughs are connected, but otherwise they may differ slightly in elevation. Within the forest, the various species of trees, with one exception, show no relation to the elevation, but are equally abundant on the sides and top of the ridges. The exception is formed by *Gleditsia triacanthos*, which regularly chooses the lower outer margin, nearest the sloughs and in the wettest soil. This feature has been observed also in other isolated groves in the county. The shrubs, if present at all, seem to prefer the margin of the forest, but in this case the controlling factor is probably light instead of water.

Some very definite and sharply marked zones of vegetation occur between the forest and the center of the pastured sloughs. The first is a zone of blue grass which extends out beyond the forest margin to a distance depending on the steepness of the slope, and down to the former level of maximum high water in the slough. Because of the continual pasturage it contains few secondary species. The second zone is composed of a very dense and rank growth of *Ambrosia artemisiifolia*, with scattered plants of *Vernonia fasciculata*, *Eupatorium serotinum*, *Bidens cernua*, *B. aristosa*, *Polygonum acre*, and *Verbena hastata*. It is probable that the dominance of *Ambrosia*, and the relative infrequency of other species, is caused by pasturing, in which certain species are selected for food, and others with rank smell or taste are avoided by the cattle and horses. This idea is substantiated by the different composition of the same zone around a slough in an unpastured field. In this tangle of weeds may be found a few scattered plants of some typical swamp hydrophytes, such as *Iris versicolor*, *Mimulus ringens*, *Scirpus fluviatilis*, and *Penthorum sedoides*. These are naturally most abundant in the deepest part of the slough, but show no present relation to contour lines (fig. 2).

Around those sloughs which contain permanent ponds a better

idea of the zonation may be gained. In such places the second zone contains some *Ambrosia*, but the dominant species are various grasses and sedges, especially *Leersia oryzoides* and *Glyceria nervata*. *Bidens aristosa* is common, and there are numerous scattered plants of the species mentioned before. Within and below this zone is a third, in which the dominant plants are again grasses and sedges, and in which *Iris versicolor*, *Mimulus ringens*, *Penthorum sedoides*, *Lippia lanceolata*, *Asclepias incarnata*, *Lobelia siphilitica*, and other



FIG. 2.—Relation of vegetation to topography; the drained slough in the foreground, with prominent clusters of *Iris*, is contrasted with the forest-covered ridge at the left.—Photograph by ARTHUR G. VESTAL.

characteristic hydrophytes are abundant. A fourth zone at the margin of the pond is characterized by *Scirpus validus*, *Salix longifolia*, *Eragrostis hypnoides*, *Eleocharis obtusa*, *E. acicularis*, and *Ludvigia palustris*.

It has not been many years since all the sloughs contained permanent standing water, which has been removed by tile drains or open ditches. By this the fourth, or innermost, zone has been destroyed completely, the third has been limited to a few scattered relics, and the second has extended in and occupied most or all of the space. Then pasturage has destroyed the dominant grasses and sedges and caused the invasion of weedy species.

Every plant listed as living in the sloughs is by preference a prairie species. Throughout the series not one typical plant of the forest has been seen. Such common and characteristic plants of floodplain swamps and oxbows as *Hibiscus militaris*, *Cephalanthus occidentalis*, and *Ambrosia trifida* are entirely absent. The oldest settlers say that there never were either white or yellow water lilies. On the contrary, they state that the margins of the sloughs were occupied by "slough grass" (*Spartina Michauxiana*) tall enough to hide a man on horseback. So it is obvious that these were prairie sloughs rather than forest swamps, and that the vegetation must have been entirely distinct from and independent of the forest vegetation of the ridges. A reconstruction of the whole grove would present a series of prairie sloughs, with grassy vegetation, alternating with the series of forested ridges. An interpretation of the phytogeographical significance of this condition will now follow.

The forest evidently indicates three stages in a successional series, beginning with the oaks and hickories at the south, passing through the bur oak stage at the center, and ending with the red oak stage near the north end. This succession is the usual one for central Illinois, and is caused, at least in part, by the gradual accumulation of humus and decrease in light. There are many other places in the state where the same series may be observed under different ecological circumstances. It is especially typical of the succession of forests on uplands along a stream, and is met with in traversing such a forest at right angles to the course of the stream. The presence of a few trees of basswood at the extreme north end may be construed to indicate the approaching development of the hard maple-basswood type of forest, the highest type found in central Illinois. Along stream courses this normally follows the red oak stage, and is located accordingly nearer the stream. The chief difference between the forests of a river system and Bur Oak Grove lies not in their structure, but in the fact that the former are connected with a general forest system extending down the river to an indefinite distance, while in the latter the grove is entirely isolated from other bodies of forest. The origin of the forests of a river system can be explained by the gradual and continuous

immigration of plants along a river highway. In the isolated grove it must be explained by a connection, no longer existent, with an older forest source, or by the sporadic development of the forest following a discontinuous migration across the prairie.

Considering the second alternative, it might be possible for the various successional stages to develop centrifugally about a small forest center, the first stage occupying an outer ring, while the following ones appeared toward the middle. This does not seem possible here, because the arrangement is so obviously unilateral, with the later stages in the succession progressively farther toward the northeast, while there is no obvious difference in the environment between the two ends of the grove, which might lead to the readier development of the red oak stage at one end. Also, in every other forest examined in central Illinois, in which oaks are the dominant trees, it has been possible to show a definite connection with some other body of forest, from which continuous migration might have taken place. In other words, oaks, with their heavy immobile seeds, do not seem able to cross tracts of prairie to a more favorable habitat, but must migrate in an uninterrupted path. There are isolated groves in Champaign County, whose structure suggests that they are the result of a discontinuous migration, but no oaks occur in them.

Considering now the first alternative, the development of Bur Oak Grove through immigration along the small streams of the vicinity is precluded for several reasons. First, their valleys are too shallow to afford the necessary physiographic diversity which always accompanies a mesophytic type of forest in central Illinois. Secondly, they all flow to the south, while in Bur Oak Grove the more mature forest type is at the north. Thirdly, they would have served as well or better for the immigration of hydrophytes than for upland species, while, as has been shown, the hydrophytic vegetation of the grove consists entirely of prairie species. The arrangement of species in the grove is exactly similar to the unilateral arrangement paralleling water courses in central Illinois. The whole grove has the appearance, and conveys the impression, of being the margin, now the only part remaining, of some extensive body of forest immigrating from the northeast, the location

of the more advanced stages, toward the southwest, the present location of the pioneer black oak and shingle oak. Of all the possibilities, development of the grove by continuous immigration from the northeast seems the only plausible explanation, and is accepted as the correct conclusion.

This idea postulates the existence in the past of a large tract of forest farther to the northeast, from which immigration into the grove took place. A few miles beyond the grove a moraine extends from northwest to southeast, perpendicular to the general direction of the forest migration, and beyond the moraine and parallel to it is the Vermillion River, bordered with a narrow belt of forest. The original source of Bur Oak Grove must be looked for at the river or along the moraine.

Several reasons lead to the belief that the moraine was the site of the ancient forest from which Bur Oak Grove was populated. In the first place, the scanty forests along the river are entirely incommensurate in size, and the distance is too great. Secondly, moraines in northeastern Illinois and parts of central Illinois are regularly forested, and other moraines in Champaign County have even now small groves upon them. Most important of all, various moraines in central Illinois have upon them forest relics which point indubitably toward a former forest covering. Thickets of hazel, an immobile forest plant not seriously injured by forest fires, are known from several places. On the moraine north of Bur Oak Grove, *Erythronium albidum*, *Trillium recurvatum*, and *Claytonia virginica* occur. These forest mesophytes produce seed in this region so seldom and propagate by vegetative means so regularly, that they cannot be considered recent invaders from the forest upon the prairie. They die to the ground in the summer, before the season of prairie fires, and their persistence on the prairie is probably due to this habit, together with their ability to withstand exposure to the full sunlight. Because of these three reasons, it seems probable that the moraine was originally covered with a forest of some luxuriance, and that from it as a center invasion of the surrounding prairies took place. Other moraines must have been similarly forested, so that in some prehistoric time a vastly larger proportion of the state was covered with forest than at pres-

ent. The entire absence of forest relics over most of the prairie makes it extremely improbable that the entire surface of the county was ever forested. The level till plains between the stream systems and the moraines were probably prairie even at the time of greatest forest advance. The immigration of the forest was restricted to the two lines of greatest physiographic diversity, the stream valleys and the moraines.

We must now account for the removal of this large body of forest from the moraine, and for the persistence of the small remainder in a few outlying tracts like the one at Bur Oak Grove. Examination of the conditions in the grove will suggest the reason, which is substantiated by other observations elsewhere in the county.

Along the western margin of the grove some of the ridges are still forested, while others are under cultivation. Examination of the vegetation along the roadsides on the cultivated ridges shows on some of them such typically forest plants as *Aster Drummondii*, *Silene stellata*, *Hedeoma pulegioides*, and others. It is evident from the flora that these ridges were originally forested also. On some other ridges these species are entirely absent, and the roadside vegetation consists of typically prairie species, as *Andropogon furcatus*, *Sorghastrum nutans*, *Panicum Scribnerianum*, *Silphium integrifolium*, *Petalostemum violaceum*, and *Parthenium integrifolium*. Evidently these ridges were originally prairie. By this method of observation of the relic plants, the exact boundaries of the grove can be determined. In this way it becomes evident that, in every case, those ridges which are or were forested are protected on the west by a conspicuous slough, while the prairie ridges extend west without interruption out upon the open prairie. Since the forested part of the grove is exclusively on the ridges, it is clear that the whole forest was protected on the west side by a series of sloughs. The prevailing winds are also from the west, and prairie fires driven to the eastward by a west wind were unable to cross the slough into the forest. It may be concluded, accordingly, that prairie fires were the chief and probably the only agent in the removal of the forest from the moraines and other places where it was not properly protected by a water barrier. The grove

at Bur Oak was benefited by a peculiar and unusual topography, and was virtually the only portion of an extensive forest system to be spared.

The origin of the prairie as a type of vegetation cannot, however, be referred to prairie fires as a cause, as was frequently supposed by early authors and occasionally even in recent years. A prairie fire presupposes a prairie, and in prairie fires we have merely one factor which has been of assistance in the maintenance or extension of the prairie in its struggle against forest invasion. In the last half century, since the cessation of prairie fires, the forests have again begun an advance into the prairie, but, as is well known, their route is chiefly up the streams, and the migration is limited to a comparatively small number of mobile species. Because of increasing cultivation, this migration is very irregular and can never lead to any serious modification in the vegetation of the region.

In conclusion, the conditions in Bur Oak Grove serve to indicate the last three periods in the vegetational history of the state:

1. Period of forest advance, leading to a great development of forests in areas of physiographic diversity.
2. Period of prairie fires, following the advent of man and leading to the restriction of the forest to protected areas and the corresponding extension of the prairie.
3. Period of civilization and the virtual cessation of the struggle between forest and prairie.

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